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Final Report
AFOSR – DURIP Grant F49620-96-1-0422
November 12, 1997

**“Momentum Resolved ESDIAD – A New Way to Study Surface
Dynamics Without a Laser”**

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An existing older Varian UHV system has been modified so that the new momentum-selective ESDIAD system can be included. All necessary electronic parts and computers have been purchased and the majority of it has been tested and used in a preliminary version of the TOF-ESDIAD system. First results are already published (see references [1-3]).

1) The following extensive changes and necessary improvements of the UHV system have been made by installing and testing the following items (compare the attached equipment list): Custom built UHV chamber (item 14); New vacuum gauges, valves and other UHV hardware (items 15,...,18,22,24).

2) Closed cycle Helium cryogenic system (item 12): In order to perform dynamic measurements at the zero point energy level (compare attached publication [3]) a new design of the manipulator including the cooling and heating system was necessary. The constructions are completed and under test in the new chamber.

3) Pulsed electron gun system (items 13 and 8): The electron gun system has been built in the new chamber and aligned (using the Precision Off Axis Port Aligner, item 15). It has been tested using a self-made phosphor screen. By employing the Avtech pulse generator (item 8) electron pulses of widths down to 500 ps could be obtained. For the pulse widths measurements the multi-scaler system (item 2), the oscilloscope (item 3) and the computer (items 10 and 11) have been employed.

4) **Specially designed detector system (item 9):** A newly designed TDC (Time to Digital Converter) has been build and tested at the University's electronic shop. The ultra fast position detector system including the multi-parameter system (item 9) is under testing at the company Quantar Technology. The delivery of the system has been delayed due to problems with the Resistive Anode. The delivery is expected at the end of November.

5) **Electronic equipment, pulsing and timing (items 1, 2, 3, 8, 10, 19, 20, 21, 23, 25):** The full capability of the new system allowing the highly time and angle resolved TOF-measurements will be possible only after including the new detector in the system. Nevertheless preliminary TOF ESDIAD measurements have been successfully performed by applying the new electronic equipment for pulsing and timing to a modified older detector system (see references [1-3]).

References:

1. J. T. Yates, Jr., J. Ahner and D. Mocuta, "Tracking the Motion of Chemisorbed Molecules on Their Adsorption Sites," submitted to Proceedings of National Academy of Sciences.
2. J. Braun, J. Weckesser, J. Ahner, D. Mocuta, J. T. Yates, Jr. and Ch. Wöll, "The Frustrated Translational Mode of CO on Cu(110): Azimuthal Anisotropy Studies by Helium Atom Scattering- A Comparison with Time of Flight ESDIAD* Measurements," submitted to J. Chem. Phys.
3. J. Ahner, D. Mocuta, R. D. Ramsier and J. T. Yates, Jr., "Measurement of Anisotropy in the Lateral Momentum of a Vibrating Adsorbed Molecule - CO/Cu(110)," Phys. Rev. Lett. 79, 1889 (1997).

Item#	Manufacturer	Catalog#	Name	Acquisition Price	Comments	Changes to the equipment list
1	Stanford Research Systems 1290 D Reamwood Ave. Sunnyvale, CA 94089	DG535 -104C -105	Digital Delay/Pulse Generator + -Option 4C Bias Tee -Option 5 Dual Rack Mount	\$3,750	Catalog Price: \$4,600	
2	EG&G Instruments, Inc., EG&G Ortec Division 100 Midland Road, Oak Ridge, TN, 37830	Model 9306	1 Ghz Preamplifier	\$541	Catalog Price: \$605	
		Model 9307	Pico-Timing Discriminator	\$1,473	Catalog Price: \$1650	
		Model 9308	Picosecond Time Analyzer	\$8,620	Discount	Not Included
		Model PCBCBC1	Computer Interface with Cable	\$265	Discount	Not Included
		Model 566	Time to Amplitude Converter	\$1,100	Catalog Price: \$1,650	
		4001A/4002D	NIM bin & 160 W power supply	\$1,999	Discount	
3	Tektronix, Inc. 700 Professional Drive, Gaithersburg, MD 20819	TDS744A	Digital Oscilloscope, 500 Mhz with Cart	\$12,200	Test Instrument	Upgrade from TDS540A in the equipment list
8	Avtech Electrosystems Ltd., P.O. Box 265, Ogdensburg, NY 13669-265	9-AVR-E2-P5 AVX-1	Pulse Generator + EA, EW, OS Options and Inverting Transformer	\$4,227	Discount	Replaces HP Programmable Pulse Generator 8114A; \$9,450
9	Quantar Technology, Inc, 3004 Mission Street, Santa Cruz, CA	3392A	MCP/RAE Sensor, 75 mm Diam. Active Area, 2MCP's, 1/100 Spatial Resolution	\$14,950	Not Received	

	3392/001	Option 001/SE: Add Electrically Isolated Front Ring to Std. 3392A	\$350		
	3392/SH	Option SH, Install 10K RAE Compatible w/Model 2502 in place of std	\$400		
	3392/SM	Option SM, Install Hot Type MCP's instead of std	\$1600		
	2502A	Model 2502A position Analyzer, High Speed	\$14,750		
	2502/X98	Add option X98 Spec Modif. To 2502 for TDC Input to FIFO	\$600		
	SPECMISC	Special Item: Modify 2502 data cables	\$450		
	MPABBS	MPA Base System w/ Small Busbox w/3 ADC Interfaces, MPA-PC 1 MB board, factory config.	\$5,400		
	MPA/2MB	Increase MPA board Memory to 2 MB	\$1,990		
	MPAWIN	MPA Windows Based Software	\$5,650		

		MPA/REPLAY	Replay/Parser Software Option for MPAWIN	\$950		
		7070	Fast 100 MHz ADC, 8192 Channel, Nim Module	\$1,675		
		FRT	Freight Charge	\$177		
10	NSA Hitachi, 100 Lowder Brook Drive, Westwood, MA 01879	CM611U	Hitachi/NSA Superscan Elite 611 Color Monitor/17"	\$700	Catalog Price: \$799	Changed Company
11	Gateway2000, 610 Gateway Drive, P.O. Box 2000, North Sioux City, South Dakota 57049-2000		Gateway G6-200 Computer	\$4,521		Changed Company
12	Advanced Research Systems, 1942 Riverbend Rd., Allentown, PA 18103		Closed Cycle Displex System + Programmable Temperature Controller + Model MB2002 Precision XYZ Manipulator + Model DPRF600 Differentially Pumped Rotary Platform	\$30,080	Discount	Included in Budget A
13	Kimball Physics Inc., 311 Kimball Hill Road, Wilton, NH 03086-9742	ELG-21EGPS-2	Low Energy Electron Gun System	\$15,440	Catalog Price: \$16,120	

14	Kurt Lesker Company, 1515 Worthington Ave. Clairton, PA, 15025		UHV Hardware	\$6,416.10	10% discount	Changed Manufacturer
			Custom Built UHV Chamber	\$8,500		Changed Manufacturer
15	MDC Vacuum Products Corp., 23842 Cabot Blvd., Hayward, CA 94545	675002	PAT-10 Precision Off Axis Port Aligner	\$650		
		675003	Precision Off Axis Port Aligner	\$750		
16	Pittsburgh Valve and Fitting Company, 49 Meade Ave., P.O. Box 4155, Bellevue, Pittsburgh, PA 15202		Various Pre-vacuum Hardware	\$4598	University Discount	
17	VAT, 500 West Cummings Park, Woburn, MA 01801	01032-CE01	Mini UHV Gate Valve	\$970		Included in Budget A
18	Varian Vacuum Products, 121 Hartwell Ave., Lexington MA 02173		Multi Gauge Controller, Various Transducers + PC Controller Boards and Cables	\$4,428.50	Discount	Included in Budget A
19	National Instruments, 6504 Bridge Point Parkway, Austin, TX 78730-5039	777158-01	PCI-GPIB and NI- 488 2M for Windows 95	\$495		
		763061-02	Type X2 double Shielded GPIB Cable, 2m, 2pc.	\$170		

		763061-04	Type X2 double Shielded GPIB Cable, 8m	\$105		
20	Hewlett Packard Co. (2609), 111 Zeta Drive, Pittsburgh, PA, 15238	HP6644A	Single-output system and power supply: 200W	\$1,912	Discount	Replaces Tectronix Power Supply
		Opt 908	Rack-mount Kit	\$29.60		
21	Dell Computer Corporation, One Dell Way, Round Rock, Texas 78682		Computer + Monitor	\$2,501		Not Included
22	Granville Phillips Company, 5675 Arapahoe Avenue, Boulder, Colorado, 80303-1398	203036-04	Variable Leak Valve / Cajon Connections/ Style 04	\$1,150		Replaces Balzers/ Pfeiffer Dosing valve in Budget A
23	Wavetek Corp., 9045 Balboa Ave., San Diego, CA 92123-1509	Model 81	50 Mhz Pulse / Function generator	\$4,080	Discount	Not Included
24	Matheson Gas Products, 166 Keystone Drive Montgomeryville PA 18936	2101182-0	Argon, Research purity, 7A cyl.	\$228		
		3813-580	Regulator, dual stage high purity stainless steel	\$729		
25	D&K Electronics, 1224 East Carson Street, Pittsburgh, PA 15203	8x36 70ns	16 MB SIMM Memory Module, 2pc.	\$338		Not Included